MA3080-MA4080-MA7080 "Mathematical Modelling"

Task for the miniproject. Chapter 1 draft.
Due till 29.10.2021
10 marks available

1. Download the data file from the BB: **WHO-COVID-19-global-data.csv** `https://blackboard.le.ac.uk/bbcswebdav/pid-3142604-dt-content-rid-14290443_2/xid-14290442`
2. Select three countries for analysis and send me (em322@le.ac.uk) list of selected countries. I'll confirm that your choice of countries is unique, or suggest you to choose a different set of countries. Your team will work with these three countries in all assignments. Please, do not select countries with population that is less than 1 million.
3. Select only the "Cumulative cases" column.
4. Define for each country the start of COVID (100 patients? 500 patients? Anything else? Decide and explain your choice).
5. Plot the cumulative data for each country with indicating the day from the start on x-axis.
6. Normalise cumulative data about COVID cases for your selected countries: divide by the country populations. Plot normalised cumulative patients COVID data as function of time from start.
7. Split the time series of each country into several waves. You can use several different heuristics for this purposes. For example, you can find (almost) horizontal fragments of a cumulative fraction plot and split time series at the internal point of each (almost) horizontal fragments. You can find inflection points. The first inflection point means end of exponential grows of the first wave, the second inflection point means end of the first wave, etc. You can find fragments of good approximation of logarithmic graph with straight lines. The first interval is exponential growth interval of the first wave, the second interval is a fragment of the saturation of the logistic grows, the third is a fragment of the exponential growth of the second wave, etc.
8. For each wave of each country, perform following actions
   (a) For the first wave take the data as is. For the second and further waves, subtract the value at the last point of previous wave from the data.
   (b) Plot the logarithms of these data.
   (c) Select period of exponential grows and identify exponent r by linear regression ($\log P \approx a + rt$).
   (d) Plot exponential growth and error of exponential growth as function of time.
   (e) Try to find the best logistic growth approximation for this wave.
   (f) Use the value of a and r from the exponential growth interval and plot the approximation for K as function of time $K(t) = P(t)\frac{1+\exp(a+rt)}{\exp(a+rt)}$. Discuss the behaviour of this function. Is it close to a constant?

9. Discuss the difference between results for the countries you selected for analysis. Do all countries have the same number of waves? Are these waves synchronous?

The expected length of the report is 2000-3000 words (with all necessary illustrations). That is 8-12 pages with figures. (Please be reasonable and do not try to use more words than necessary.) Do not forget about reasonable references.